Navigation and Ancillary Information Facility Services for Discovery Missions

NASA's Navigation and Ancillary Information Facility (NAIF) is responsible for design and implementation of the SPICE ancillary information system described below. The SPICE system can be used to assist Discovery PI teams in mission design, mission planning, observation planning, and interpretation of scientific observations. SPICE helps the Discovery team work in concert with Mission Operations services; it does not compete with nor replace those components.

SPICE data sets are produced by a number of Mission Operations services, such as Navigation, Spacecraft Engineering and Sequencing. These data include some contributions by the PI. The SPICE data sets and related software are made available to PI team members, and may also be used by some Mission Operations services.

The primary SPICE data sets, called "kernels" or "kernel files", contain a fundamental set of ancillary information of potential interest to scientists and engineers. SPICE kernel contents are summarized below.

S **S**pacecraft ephemeris, or more generally, location of an observer, given as a function of time.

P **P**lanet, satellite, comet, or asteroid ephemerides, or more generally, location of a target, given as a function of time.

The **P** kernel also includes certain physical, dynamical and cartographic constants for target bodies, such as size and shape specifications, and orientation of the spin axis and prime meridian.

I **I**nstrument description kernel, containing descriptive and operational data peculiar to a particular scientific instrument, such as mounting alignment, internal timing relative to the spacecraft clock, and field-of-view model parameters.

C Pointing kernel, containing a transformation traditionally called the **C**-matrix which essentially yields time-tagged pointing (orientation) angles for a spacecraft structure upon which science instruments are mounted.

E **E**vents kernel, the principal contents of which are derived from the integrated sequence of events used to produce actual spacecraft commands. Also part of the Events kernel is an electronic Experimenter's Notebook.

Several miscellaneous kernels––spacecraft clock and leapseconds––are also part of SPICE; these are used in converting time tags between various time measurement systems.

The SPICE system includes subroutines needed to read the kernel files and calculate most common observation geometry parameters. Users integrate these "SPICE Toolkit" subroutines into their own application programs to compute observation geometry parameters and related information when and where needed. Extensive software documentation and examples are provided with the Toolkit. The Toolkit also includes some subroutines used in writing SPICE kernels.

The Toolkit software was originally written in FORTRAN but is now available in C as well. The Toolkit software is portable to any computer platform that supports ANSI FORTRAN or C. These subroutines may also be accessed from other languages on most platforms.

The SPICE files may be ported between heterogeneous platforms, either as ASCII (text) files or using utility programs contained in the SPICE Toolkit.

"Predict" SPICE kernel files may be generated for mission planning and observation design purposes. "Actual" or "reconstruction" SPICE kernel files––based on processed telemetry––are produced during flight operations to support detailed science data analyses. Both kinds of SPICE kernels are often used in mission engineering.

While most SPICE kernel files are usually produced by the mission operations team supporting the PI, the PI may also produce SPICE kernel files. PI-produced SPICE files are often a result of science data analysis––for instance, improvement in instrument pointing based on interpretation of what the sensor saw, or new estimates of a target body's size, shape and orientation.

The principal advantage of using SPICE is that the Discovery PI gets considerable, well tested planning and data analysis functionality for modest cost. Also, it's possible the PI's staff may already be familiar with SPICE from previous work. Additionally, SPICE is NASA's Planetary Data System standard for archiving ancillary data from planetary missions, so use of SPICE up front will facilitate meeting archiving requirements.

More information about NAIF and the SPICE system can be obtained from: cacton@spice.jpl.nasa.gov   or   (818) 354-3869